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AUTHOR Ogunsola-Bandele, Mercy F.
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ABSTRACT

Physics has been reported to be the least popular of the science subjects among high school students in Nigeria. In fact the low enrollment and poor grades even for majority students that enroll has been a great concern to most science teachers and curriculum planners. This study examined students' attitudes on the teaching and learning of physics. Particular attention was focused on students' views on the influence of the knowledge of mathematics on the learning of physics. The sample consisted of 104 high school students from 3 different schools in Kaduna State, north of Nigeria. A 25-item instrument based on the 4-point Likert scale of responses was administered to the students during their normal class. The results obtained revealed that although students enjoy and are interested in studying physics, there are a number of problems encountered: too many facts/technical terms to learn, the textbooks are difficult to read, and the students would rather do without the mathematical aspect for it lowers their grades in the subject. The implication of this to the curriculum developers is discussed. Contains 21 references. (Author)

MATHEMATICS IN PHYSICS---WHICH WAY FORWARD: THE INFLUENCE OF MATHEMATICS ON STUDENTS' ATTITUDE TO THE TEACHING OF PHYSICS

By

Dr. Mercy F. Ogunsola-Bandele

ABSTRACT

Physics has been reported to be the least popular of the science subjects among high school students in Nigeria. Infact the low enrolment and poor grades even for majority that enrol has been a great concern to most science teachers and curriculum planners. (Abdullahi 1982; Badmus 1986; Olaniyi 1985; and Turton 1991).

This study therefore examined students' attitude on the teaching and learning of physics. Particular attention was focussed on students' views on the influence of the knowledge of mathematics on the learning of physics.

The sample consisted of 104 high school students from 3 different schools in Kaduna State, North of Nigeria. A 25-item instrument based on the 4-point Likert scale of responses was administered to the students during their normal class.

The results obtained revealed that although students enjoy and are interested in studying physics, there are a number of problems encountered: too many facts/technical terms to learn, the textbooks are difficult to read and the students would rather do without the mathematical aspect for it lowers their grades in the subject. The implication of this to the curriculum developers are discussed.

INTRODUCTION

Many researchers for sometime now, have argued that students' achievement in the sciences depend on their knowledge and understanding of a number of mathematical concepts and skills (Fakuade 1977, Lewis 1972, Ogunsulire 1977, Rennie and Parker 1996). This argument has been stronger for physics which is one of the fundamental science courses experiencing low enrolment (Abdullahi 1982, Bryant 1977, Sobolewski and Doran 1996). Students' perception that the course is difficult and the inaccessability to the course because of its prerequisite (other science and mathematics courses) discourages some students from enrolling (Chandavarkar 1991). For according to Sobolewski and Doran (1996), in some high schools, physics course is placed at the end of the science curriculum so that students have to succeed in earth science, biology, and chemistry to be able to get to physics. Other reasons for the low enrolment included lack of enthusiastic and qualified physics teachers. (Franz 1983). For the physics teachers that generally feels insecure, dreads and dislike mathematics, would naturally transmit this to the students.

If there exists a relationship between physics and mathematics, then one goal of physics instruction should be to develop curriculum that will overcome these commonly recognizable misconceptions and help students to connect the physics and mathematics concepts with their everyday experiences. The importance of coordinating the teaching of mathematics and physics at high school in particular has been underscored by many educators (Servais 1966). Infact better cooperation between mathematicians and other users of mathematics that ought to have been one of the by-products of curriculum reforms has regrettably been lacking (Webb 1973).

Depressingly in Nigeria, little work has been done about coordination of these, presumably related subjects (Badmus 1986). Kalejaiye (1979) examined the traditional mathematics and science (physics inclusive) programmes with the 6 year mathematics programme which was to be introduced then in 1982 in all Nigerian schools in order to assess the adequacy of mathematics content. It was found that both the traditional and 'so-called' new curricula provided all the mathematics needed for the sciences with the new curricula being more adequate. Also from a similar study reported by Badmus (1986), 27 out of the 36 identified mathematics concepts, processes and skills seem to be most important for the mastery of high school physics proscribed by one of the physics curriculum.

Although results from these studies are not intended to suggest that mathematics curriculum should be built according to the mathematical needs of science in general or of physics in particular, however, since the changes being undertaken at the high school level cost so much in time, money and efforts, improved coordination between mathematics and the sciences in general should be included as one of the objectives of curriculum revision or improvement. Clearly, it might be difficult coordinating a given mathematics programme with the mathematical concept of all the sciences. But an alternative would be to assess the existing mathematics programmes with each of the existing curricula in the sciences and select the most suitable for the different categories of students: physical science students, biological science students, social science students, and so on. (Badmus 1986).

This attitude to physics seems to cut across the developed world. For instance Rennie & Parker (1996) also investigated students responses to a variety of physics problems which

vary in terms of preference for task format which included students preference for explanation or calculation questions. About 60% of the students preferred explanation questions because there were 'no maths and confusing formulas'. On the other hand, a major reason (70%) for preferring calculation questions was that 'you only had to know the formulas/equations and didn't have to think too much.'

From the foregoing, it seems that most students are finding it difficult to cope with the mathematics in physics. The present study therefore examines students attitude to the teaching and learning of physics and the nature of the subject. Particular attention was focussed on students views/attitude on the influence of the knowledge of mathematics on learning physics.

Sample

By simple lottery method of selection, three schools in Kaduna State, North of Nigeria were randomly selected. A total of 104 students from these schools participated in completing the questionnaires for the research.

Instrumentation and Collection of Data

A 25-item instrument similar to that of Otuka (1986) and Anaso (1996) was used to collect data for the study. It was based on the 4-point Likert Scale of responses - Strongly Agree (SA), Agree (A), Strongly Disagree (SD) and Disagree (D). The attitude test included statements that were both positive and negative to ensure that the students read all the statements carefully before responding. Students were asked to tick ( ) only one option. The instrument had four sections: personal information, general attitude towards the teaching/learning of physics, the nature of the subject and the mathematics influence on students attitude.

The content validity of the instrument was established by having the items evaluated by three physics teachers and two psychologists. Their suggestions led to the elimination and reframing of some of the attitude statements. The reliability of the instrument is 0.78 using Spearman Brown split-half reliability method.

Results

To find out students general opinion on the teaching and learning of physics, the following ten questions were analyzed as shown on Table I. In the general analysis, the responses were merged into two: strongly agree and agree for agree responses, and strongly disagree and disagree for disagree responses.

Table I - students attitude towards the teaching/learning of physics.

	Specific attitude Statements	Strongly Agree	Agree	Strongly disagree	Disagree
1.	Of all the subjects I enjoy physics most	34 (32.69)	41 (39.42)	23 (22.11)	6 (5.76)
2.	I want to pursue a career that requires adequate knowledge of physics	47 (45.19)	36 (34.61)	11 (10.57)	10 (9.61)
3.	Physicists are very useful in the society	64 (61.53)	30 (28.84)	10 (9.61)	0 0.00
4,	Everyone should have some knowledge of physics	45 (43.26)	27 (25.96)	24 (23.07)	8 (7.69)
5.	Physics helps me to understand other science subjects	62 (59.61)	32 (30.76)	8 (7.69)	2 (1.92)
6.	Physics as a subject is not as interesting as other science subjects	11 (10.57)	9 (8.65)	37 (35.57)	47 45.19
7.	The teachers teaching approach has increased my interest in the subject	41 (39.42)	35 (33.65)	16 (15.38)	12 (11.53)
8.	The teachers teaching approach makes me look forward to physics lessons	35 (33.65)	41 (39.42)	19 (18.26)	9 (8.65)
9.	I do not need to read physics to succeed in life	16 (15.38)	22 (21.15)	30 (28.84)	36 (34.61)
10.	The study of physics has enabled me realize that a lot of science activities go on in my home.	37 (35.57)	43 (41.34)	15 (14.42)	9 (8.65)

The percentages are indicated in brackets.

From the results obtained on table I, it could be seen that most (72.11%) of the students in the three schools agreed that they enjoy physics, it is an interesting subject (80.76%) and would like to pursue a physics related career (79.80%). This opinion was buttressed by the facts expressed in items 3,4 and 10 that physics is useful in the society (90.37%), knowledge gained in the subject helps in the home (76.91%) and thus recommends that everyone should have some knowledge of physics (69.22%). However it is interesting to find out from item 5 that physics helps majority (90.37%) of the students to understand other science subject. This should have been the reverse - that is, other science subjects helping to understand physics according to the school curricular reported by Sobolewski and Doran (1996).

As regards the teachers teaching approach, most students (73.07%) claim that the teachers approach has increased their interest and motivated them to learn the subject. This again does not support Franz's (1983) report that students low enrolment in physics is due to lack of enthusiasm of the teachers.

But if the students find the subject so interesting and they enjoy it, then why the low enrolment and achievement reported by various researchers in the subject. Table II considers student's attitude to the nature of the subject.

Table II - students attitude to the nature of the subject (physics)

	Specific attitude Statements	Strongly Agree	Agree	Strongly Disagree	Disagree
11.	Physics is a very difficult subject	46 (44.23)	32 (30.76)	6 (5.76)	20 (19.23)
12.	There are too many facts to learn in physics	35 (33.65)	50 (48.07)	12 (11.53)	7 (6.73)
13.	Physics textbooks are difficult to read and understand	40 (38.46)	25 (24.03)	24 (20.19)	18 (17.30)
14.	Physics is mainly for intelligent people	26 (25.00)	27 25.96	28 (26.92)	23 (22.12)
15.	Physics has many technical terms which are easy to remember	13 (12.50)	18 (17.30)	36 (34.62)	37 (35.58)
16.	The teachers approach made the subject difficult to understand	11 (10.58)	19 (18.26)	40 38.46)	34 (32.69)

The percentages are indicated in brackets.

From the results obtained on table II, despite the fact that most students, (72.11%) claimed that they enjoy physics (table I), 74.99% of the students were of the opinion that the subject is very difficult. Infact 81.72% of the students agreed that there are too many facts to learn, too many technical terms to remember (70.20%) and the textbooks are also difficult to understand (62.49%). Nevertheless, majority of the students (71.15%) disagreed on the teachers teaching approach being responsible for the difficulty encountered in understanding the subject.

A fair distribution of the students (50.96% - Agreed and 49.04% Disagreed) was recorded on students opinion on whether the subject was meant for intelligent people. This means that although majority of the students find the subject difficult, the students still feel that everyone could learn it might be by reducing the facts, technical terms and restructuring the curriculum. One way of getting at the problem was to find out the students attitude towards the mathematics content of the curriculum (Table III).

Table III - students attitude on the influence of the knowledge of mathematics on physics.

	Specific attitude Statements	Strongly Agree	Agree	Strongly Disagree	Disagree
17.	Mathematics helps me in understanding physics	68 (65.38)	34 (32.69)	2 (1.92)	0 0.00
18.	I would do better in physics if there is no calculation in it.	38 (36.53)	37 (35.57)	18 (17.30)	21 (10.57)
19.	I would prefer to do some physics calculations than read physics	17 (16.34)	18 (17.30)	35 (33.65)	34 (32.69)
20.	The calculations in physics makes me score lower in the subject.	31 (29.80)	40 (38.46)	19 (18.26)	14 (13.46)
21.	I feel like walking out of the class when the teacher starts to write equations on the board	42 (40.38)	37 (35.57)	16 (15.38)	9 (8.65)
22.	Knowing formulas and equations has not got anything to do with understanding physics.	15 (14.42)	16 (15.38)	39 (37.50)	34 (32.69)

23.	A good grade in mathematics should be a pre-requisite to studying physics.	46 (44.23)	32 (30.76)	18 (17.30)	8 (7.69)
24.	I would like to identify myself with mathematics students in the school.	50 (48.07)	42 (40.38)	10 (9.61)	2 (1.92)
25.	The emphasis on the calculations in physics should be decreased	40 (38.46)	23 (22.11)	31 (29.80)	10 (9.61)

The percentages are indicated in brackets.

From results on table III, most of the items generated high percentages of agreeing responses on the influence of mathematics on physics. Infact almost all the students (98.00%) agreed on the importance of the knowledge of mathematics in understanding physics which is indicated by their wish to identify with mathematics students in the school (88.45%) and recommending a good grade in mathematics as a pre-requisite to physics (74.99%).

However the students would rather do without the calculations involved in physics (66.34%) moreso as it lowers their overall grade in the subject (68.26%). Also the sight of formulas and equations on the chalk board frightens most of the students (75.95%) that they feel like walking out of the class. No wonder the students (60.57%) were suggesting a decrease on the emphasis on calculations in physics.

Discussions

The results obtained so far revealed that although students enjoy and are interested in studying physics, they encountered some difficulties: too many facts/technical terms to learn, the textbooks are difficult to read and the students would rather do without the mathematics calculations involved in physics for it lowers their overall grade in the subject. No wonder Medahunsi (1986) reported that despite all the attention paid to mathematics curriculum, most students leave school with very little conceptual basis of understanding mathematics. According to him, they are not very skillful at using mathematical ideas and have rather negative attitude about the subject. This negative attitude is usually carried to other mathematics related subject and thus students having cognitive difficulty with some concepts. (Goldberg & Anderson 1989, Brungardt & Zollman 1995).

It seems that most students can cope with real life context in their attitude to physics with a little more practice on the indicated difficult aspects. For according to Rennie & Parker (1996) the application of physics in real-life context are usually more difficult conceptually than abstract applications because more variables are involved; some of which are difficult to identify let alone measure. Nevertheless, perhaps the intrinsic interest indicated by the students could be an avenue for enhancing students desire to attend to the

physics at the appropriate cognitive level.

Looking at the section on the problems students are facing in understanding physics textbook (item 13) as well as their performances in continuous assessment/examinations (item 20), Hazel et al 1996 emphasized that quantitative questions (these involve numeric and algebraic answers) predorminate in most cases. For there is the belief that experience in dealing with quantitative problems is very important to physics students. Yet the literature (Rennie & Parker 1996, Hazel *et al* 1996) of students conception of physics signals that students might be able to perform well on quantitative questions without adequate qualitative understanding of the concepts. Infact Hazel *et al* (1996) found that students who did well on qualitative questions could not explain the underlying concepts.

The implication of this is that physics assessment packages should always include both qualitative and quantitative questions. For quantitative questions should be supplemented by short flexible questions, essay, posters and reports which requires the students to explain and discuss concepts and their applications; to explain the working involved in a quantitative question and encourage students to link the abstract to concrete. This would enable students demonstrate the knowledge and understanding they possess and can reward them for taking a broader view for integrating, synthesising or evaluating (Hazel et al 1996).

The interest and the attitude the teachers showed towards the teaching of physics (items 7,8 and 16) to a large extent determined the attitude exhibited by the students. No wonder, the students expressed enjoying the subject despite the various difficulties encountered. This attitude is what is expected of teachers and should be commended.

Finally, it is hoped that this study will draw the attention of the curriculum developers to this important facet of the physics curriculum especially when the opportunity arises for a revision. So that the qualitative and quantitative aspects can be integrated and synthesised.

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